I Claim:

Sub A4

1.) A receiver for identifying a message based upon a received signal, the receiver comprising:

a processor that generates a minimum threshold and a maximum threshold representing a variable range for each of a plurality of possible message levels, and

a comparator that identifies the message by comparing the received signal with the generated minimum and maximum thresholds.

2.) The receiver according to claim 1, wherein the minimum and maximum thresholds are a function of an interrelationship between noise and the message level.

3.) The receiver according to claim 2, wherein the minimum and maximum thresholds are a function of the interrelationship between digital impairment and the message level.

4.) The receiver according to claim 2, wherein the minimum and maximum thresholds are a function of the interrelationship between coherent noise and the message level.

5.) The receiver according to claim 1, wherein the generated minimum and maximum thresholds define a range wherein the probability of correctly receiving a selected signal exceeds a selected probability P0.

6.) The receiver according to claim 5, wherein the processor includes a means for calculating the mean value, Lev(i), within a selected range defined by a selected set of minimum and maximum thresholds.

7.) The receiver according to claim 6, wherein the processor includes a means for calculating a distance d(i) between received signal levels, the distance d(i) being calculated according to the equation:

$$d(i) = Lev(i+1) - Lev(i) - Lmse(i+1) - Lmse(i),$$

wherein the term "i+1" identifies a message level adjacent the i^{th} message level in the constellation design for the receiver and wherein Lmse(i) is the level mean square error for the i^{th} message level.

8.) The receiver according to claim 7, wherein the distance $d(i) > d_{min}$ for all message levels.

9.) The receiver according to claim 1, wherein the processor includes means for determining a distance d(i) between received signal levels, the distance d(i) having different values for a plurality of message levels.

Sub A13

10.) A method of forming a constellation design having a selected number of (i) message levels, the constellation design forming part of a receiver that identifies a transmitted message based upon a received signal, the method comprising:

determining a minimum threshold and a maximum threshold representing a variable range for each of a plurality of possible signal levels, and

calculating the distance d(i) between possible signal levels based upon the determined minimum and maximum thresholds.

11.) The method according to claim 10, wherein the determining step comprises the steps of:

identifying a probability density function for each possible signal level Y, and

identifying the minimum and maximum thresholds as the boundaries of a range in the identified probability density function wherein the probability of correctly receiving a selected message level exceeds a selected probability P0.

12.) The method according to claim 11, wherein the step of identifying the probability density function comprises the steps of:

transmitting data points to the receiver, and

recording the received signal level associated with each of the transmitted data points.

13.) The method according to claim 10, wherein the step of calculating the distance d(i) between received signal levels further includes the steps of:

determining the mean value, Lev(i), for a selected variable range identified by a selected set of minimum and maximum thresholds, and

calculating the distance d(i) as a function of Lev(i).

14.) The method according to claim 13, further including the step of calculating the distance d(i) in accordance with the equation:

$$d(i) = Lev(i+1) - Lev(i) - Lmse(i+1) - Lmse(i);$$

wherein the term "i+1" identifies a message level adjacent the i^{th} message level in the constellation design for the receiver and wherein Lmse(i) is the level mean square error for the i^{th} message level.

15.) The method according to claim 13, further comprising the step of identifying whether the calculated distance $d(i) > d_{min}$, wherein d_{min} represents a selected minimum value.

16.) The method according to claim 15, further comprising the step of adjusting the constellation design such that the distance $d(i) > d_{min}$ for all received signal levels in the constellation design.

17.) The method according to claim 12, further comprising the step of calculating the mean value, Lev(i), according to the equation:

$$Lev(i) = \frac{1}{N}\sum_{i=1}^{N} L(i),$$

wherein L(i) is the training data received by the receiver, and

N is the number of times training data for the i^{th} level is sent.

18.) The method according to claim 17, further comprising the step of calculating the standard mean square error, σ^2, according to the equation:

$$\sigma^2 = \frac{1}{N}\sum_{i=1}^{N}[L(i) - Lev(i)]^2.$$

19.) The method according to claim 18, further comprising the step of calculating the Lmse(i) according to the equation:

Lmse = $\alpha\sigma^2$,

where α meets the following

$$P0 = \frac{\int_{-\alpha\sigma^2}^{\alpha\sigma^2} e^{\frac{-x^2}{2\sigma^2}}dx}{\int_{-\infty}^{\infty} e^{\frac{-x^2}{2\sigma^2}}dx}$$, where P0 is a selected probability.

20.) A receiver for identifying a transmitted message based upon a received signal, the receiver comprising:

a processor for generating a constellation design having a minimum threshold and a maximum threshold for each of a plurality of possible signal levels, the minimum and maximum thresholds representing a variable range that may differ between possible signal levels, and

a comparator that identifies the transmitted message by comparing the received signal with the generated constellation design and that generates an output signal representative of the transmitted message.

21.) A method of identifying a message based upon a received signal, the method comprising:

receiving the signal,

generating a minimum threshold and a maximum threshold representing a variable range for each of a plurality of possible message levels, and

identifying the message by comparing the received signal with the generated minimum and maximum thresholds.

22.) The method according to claim 21, wherein the minimum and maximum thresholds are generated as a function of an interrelationship between noise and the message level.

23.) The method according to claim 22, wherein the minimum and maximum thresholds are generated as a function of the interrelationship between digital impairment and the message level.

24.) The method according to claim 22, wherein the minimum and maximum thresholds are generated as a function of the interrelationship between coherent noise and the message level.

Sub B1

25.) The method according to claim 21, wherein the generating step includes the step of calculating a variable range Lmse(i) for each possible message level Y, Lmse(i) representing one-half the distance between the minimum and maximum thresholds for each possible message level, wherein the minimum and maximum thresholds define a range wherein the probability of correctly receiving a selected signal exceeds a selected probability P0.

26.) The method according to claim 25, further including the step of calculating the mean value, Lev(i), within a selected range defined by a selected set of minimum and maximum thresholds.

27.) The method according to claim 26, further including the step of calculating a distance d(i) between received signal levels, the distance d(i) being calculated according to the equation:

$$d(i) = Lev(i+1) - Lev(i) - Lmse(i+1) - Lmse(i).$$

28.) The method according to claim 21, further including the step of determining a distance d(i) between received signal levels, the distance d(i) having different values for a plurality of message levels.

29.) The method according to claim 28, wherein the step of calculating the distance d(i) between received signal levels further includes the steps of:

determining the mean value, Lev(i), for a selected variable range identified by a selected set of minimum and maximum thresholds, and

calculating the distance d(i) as a function of Lev(i).

30.) The method according to claim 28, further comprising the step of identifying whether the calculated distance $d(i) > d_{min}$, wherein d_{min} represents a selected minimum value.

31.) The method according to claim 30, further comprising the step of adjusting the constellation design such that the distance $d(i) > d_{min}$ for all received signal levels in the constellation design.

Sub A8

32.) The method according to claim 21, wherein the generating step comprises the steps of:

identifying a probability density function for each possible signal level Y, and

identifying the minimum and maximum thresholds as the boundaries of a range in the identified probability density function wherein the probability of correctly receiving a selected message level exceeds a selected probability P0.

33.) The method according to claim 32, wherein the step of identifying the probability density function comprises the steps of:

transmitting data points to the receiver, and

recording the received signal level associated with each of the transmitted data points.

34.) The method according to claim 33, further comprising the step of calculating the mean value, Lev(i), according to the equation:

$$Lev(i) = \frac{1}{N}\sum_{i=1}^{N} L(i),$$

wherein L(i) is the training data received by the receiver, and N is the number of times training data for the i^{th} level is sent.

35.) The method according to claim 34, further comprising the step of calculating the standard mean square error, σ^2, according to the equation:

$$\sigma^2 = \frac{1}{N}\sum_{i=1}^{N}[L(i) - Lev(i)]^2 .$$

Sub A19

36.) The method according to claim 35, further comprising the step of calculating the Lmse(i) according to the equation:

Lmse = $\alpha\sigma^2$,

where α meets the following

$$P0 = \frac{\int_{-\alpha\sigma^2}^{\alpha\sigma^2} e^{\frac{-x^2}{2\sigma^2}} dx}{\int_{-\infty}^{\infty} e^{\frac{-x^2}{2\sigma^2}} dx}$$, where P0 is a selected probability.

Add B2